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ABSTRACT

This document, a report to the Michigan Council of Teachers of Mathematics (MCTM), contains the viewpoints and recommendations of a study group set up to determine the reactions to and implications of the Conference Board of the Mathematical Sciences National Advisory Committee of Mathematical Education (NACOME) publication, "Overview and Analysis of School Mathematics, Grades K-12." The areas of curriculum, instruction, teacher training, and evaluation were addressed. The study group directs most of the recommendations to MCTM or the Michigan Department of Education for action. The view expressed is that dissemination of these recommendations is a necessary first step in implementing selected ideas from the NACOME study. (MP)

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# REPORT OF THE MCTM/NACOME STUDY GROUP

## NOVEMBER 1976

# Implications for Mathematics Education In Michigan for the 1980's

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A project jointly funded by the Michigan Council of Teachers of Mathematics and the Committee on Affiliated Groups of the National Council of Teachers of Mathematics.

The views expressed in this report do not necessarily reflect the policy or position of either the MCTM or the NCTM.

SE 036 342

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# PREFACE

The Conference Board of the Mathematical Sciences National Advisory Committee on Mathematical Education (NACOME) has published a thought-provoking study, Overview and Analysis of School Mathematics, Grades K-12.*

The recommendations in the NACOME Report were examined and discussed at a two-day conference held in July at the Kellogg Center. The study group consisted of school administrators, teacher trainers, classroom teachers and mathematics specialists.

The purpose of these deliberations was to determine the reactions to and implications of NACOME's recommendations for mathematics education in Michigan. Preliminary reports of the study group were given at four general interest sessions during the MCTM Annual Conference in October. Feedback from these sessions provided valuable input. This report to the Michigan Council of Teachers of Mathematics contains the viewpoints and recommendations of the study group in the areas of curriculum, instruction, teacher training and evaluation. We urge that the MCTM Executive Committee give prompt attention to these recommendations.

The study group's conference and this report were jointly funded by the MCTM and the NCTM's Committee on Affiliated Groups. We gratefully acknowledge their help in this endeavor.

Special thanks go to Shirley Hill, University of Missouri and chairperson of NACOME, who so graciously attended the conference as a resource person. We also appreciated the dual role of Pheta Rubenstein as participant and resource person. Much insight was gained by the study committee through the background provided by Shirley and Rheta.

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*The "Overview and Analysis of School Mathematics, Grades K-12" is available through the ERIC system, document number ED 115 512. In addition, single copies (while they last) are avilable from the Conference Board of the Mathematical Sciences, Suite 832, 2100 Pennsylvania Avenue, N.W., Washington, D. C. 20037.

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## INTRODUCTION

Shirley Hill's opening comments to the MCTM/NACOME Study Group were punctuated with observations of the very active and influential Mathematics Education Community in Michigan. She documented the observation particularly by citing the influence of Lauren Woodby and Eugene Smith, professors of mathematics education at Michigan State and Wayne State Universities, respectively, in the acquisition of support, design and implementation of the NACOME Study. Further: a member of NACOME, Rheta Rubenstein is a mathematics teacher at Murray-Wright High School in Detroit, Joseph Payne, of the University of Michigan, was instrumental in the authorization of the second printing of the NACOME report: and the press conference held to announce the release of the NACOME report was in Ann Arbor. And now, the first group to assemble specifically to study the NACOME report was the presently congregated group of Michigan educators-teachers, administrators and mathematics teacher educators.

The audience for which the NACOME Report was written, are a diverse group. Parents were considered, as were educational policy-makers, teachers, teacher educators, mathematicians and -- as it turns out -- journalists, along with the organizations to which these different groups affiliate. Shirley used the journalists' questions to demonstrate how different parts of the report were of interest to different groups. The journalists considered three questions to be "newsworthy":

What happened to the New Math?
Why are test results declining?
What about the calculator?

Paraphrasing Shirley, she indicated that as Michigan educators, we certainly would not be unconcerned with the journalists' perceived critical issues in mathematics education. However, she exhorted the assembled group to consider the more pervasive and instructionally relevant issues highlighted and documented by the NACOME report. Although she cited and discussed others, three received obviously heavy emphasis. These were:

What are the goals of mathematics education?
What are basic mathematical skills today?
What is happening in mathematics classrooms?

Though it was presented as less than absolute, the consensus seemed to be that the goals of mathematics education are not clear; i.e., teachers, mathematics teacher educators and other educators cannot clearly articulate "why we do what we do" and "where we are going in school mathematics." One present ill-consequence of such a predicament is the discrepancy in what some present evaluation instruments measure and our (the mathematics educators) contention that those instruments are not measuring all that we're teaching. Rheta Rubenstein's admonition that teachers be collaborators in mathematics education decisions is nowhere more warranted than within the goals issue. Clearly, teachers have a greater percent of the responsibility of "how" to teach than the percent of responsibility of "what" to teach, but they must be a partner in the goals and objectives decisions along with representatives from state and local education agencies, institutions of higher education, and the community.

The NACOME report itself, as Shirley pointed out, indicated that basic mathematical skills are more than the common computation skills syndrome. The National Institute of Education's Basic Skills division has available upon request a 200 plus page volume of Basic Mathematical Skills, which is a collection of at least 20 persons' views of what the Basic Mathematical Skills are. Views stated in this volume are often in agreement with those of the NACOME report which include such items as basic statistics concepts, logical framework of mathematics and symbolism, abstraction and precise language.

Thirdly, the question, "What is happening in mathematics classrooms?", signals an awareness that little is known about classroom practices in general and mathematics classroom

practices in particular. In America, we've had some assumptions, but the NACOME report illuminates the absence of data to document those assumptions. In fact, one can immediately associate this state of not knowing with Nevelle Bennett's comments in Teaching Styles and Pupil Progress (1976). He cites the 1967 Plowden Report (Great Britain), "The report welcomed the introduction and proliferation of more progressive methods ..." Hence, many have thought this was the trend and widespread practice in Great Britain. However, a recent survey revealed that at most "...17 percent of the teachers teach in the manner prescribed by Plowden..." The NACOME Report indicates that we don't have even this much information about classroom practice in the U.S.A. If this data is to be acquired, Rheta Rubenstein's observation of the necessity of teacher involvement is magnified.

Shirley and Rheta's hope was that the NACOME report and this MCTM Study Group would lead to action for mathematics in Michigan. Thus, the Study Group began its work with a chapter by chapter approach to flush out the implications for improving present practice, development and research in mathematics education in Michigan. These implications would particularly focus on goals, basic skills and classroom practice.

# MCTM/NACOME SUB-COMMITTEE ON CURRICULUM

The four sections in the NACOME Report, Chapter 1, pages 23-48 of Chapter 2, pages 138-139 of Chapter 6, and pages 145-146 of Chapter 6, were studied by the MCTM Sub-Committee. Subsequently, it prepared this report, presented now in four sections.

Section I--OVERVIEW deals with overall reactions to the NACOME Report on curriculum with specific recommendations on the amount of mathematics content in schools. on calculators, on geometry, on Congressional and Legislative relations and on the need for a central repository for current curriculum materials. Section II--BASIC SKILLS contains a statement about basic skills, and how they should be defined and how they might be included in the curriculum. Section III--CURRICULA FOR ALL STUDENTS deals with mathematics for remedial instruction, mathematics for the gifted student, and a broader selection of course offerings. Section IV--METRIC EDUCATION summarizes activities in Michigan on metric education and makes recommendations for curriculum study growing from the introduction of the metric system in schools.

## I. OVERVIEW

The MCTM Sub-Committee on Curriculum is in general agreement with the NACOME analysis of the curriculum reform 1955-1975 as contained in Chapter 1, pages 1-22. We would stress one sentence in the summary on page 21:

> From a 1975 perspective the principal thrust of change in school mathematics remains fundamentally sound, though actual impact has been modest relative to expectations.

The analysis of goals, pages 1-4, seems accurate and thoughtful. The assessment of the extent of implementation of newer mathematics programs (pp. 4-14), during this period is realistic. In the analysis of the innovations, the Committee did an adequate assessment of major features of the changes in the mathematics curriculum. In the opinion of the MCTM Sub-Committee, however, NACOME omitted one major feature of the curriculum reform from 1955-1975. NACOME did not mention increased mathematical content at almost every grade level in school.

Amount of Mathematical Content in Schools

The MCTM Sub-Committee recognizes that there has been a "content crunch" in many mathematics courses, with too much content included for most students who are enrolled. For example, computational expectations have risen substantially in the primary grades. Prior to 1955, it was not uncommon for arithmetic in grades one and two to be limited to facts with sums to ten. Now, all addition and subtraction facts are taught as well as addition and subtraction algorithms. Some curriculum materials include subtraction wtih renaming in grade two. While most schools recognize the need for more content, it is almost an axiom that major increases in content expectations at given grade levels will cause more pupils to have difficulties with mathematics.

Among secondary school courses, geometry and eleventh year mathematics are examples of courses with substantially increased content in the 1955-1975 period. Most textbooks for secondary school geometry now include solid geometry, put increased emphasis on axiomatics and have coordinate geometry. If all the content in the textbooks is taught, the increase in content expectations in this single course is estimated to be at least 25%. In college preparatory eleventh grade mathematics, inclusion of trigonometry, increasing the attention to proof and to axiomatics, and more stress on structure all combine to increase the content expectations by at least one-third. Senior

mathematics for college preparatory students has become a very substantial course, enabling well-prepared students to begin calculus as freshmen in college--a desirable goal for many of our more able secondary school students.

While textbooks must contain enough material to give teachers some options, depending on the abilities of students in the class, there has been too much content for a great many students. The present changes in school mathematics is viewed by the MCTM Sub-Committee as making curriculum modifications in what has been excessive demands on some students.

> Recommendation: The Michigan Council of Teachers of Mathematics should work in close cooperation with schools and with the State Department of Education in making suggestions for realistic expectations of students in the various school mathematics courses. Efforts should be made to give direction to content that can and should be deleted from the crowded curriculum.

This recommendation should be interpreted in light of the MCTM Sub-Committee comments at the end of Section II on minimum competencies. Furthermore, variations in expectations should reflect differing abilities of students.

In Chapter 2, pages 23-48, NACOME identified the current directions and issues in curriculum. The MCTM Sub-Committee agrees quite enthusiastically with the analysis of needed direction in applications, curriculum for less able students, needs related to computers, effects of calculators, changes related to the metric system, and trends in statistics and probability. The MCTM Sub-Committee agrees also with the NACOME assessment of the present-day excessive preoccupation with computation. At an open hearing at the MCTM Meeting, a teacher suggested that applications need to include uses related to specific trades, so that teachers could have better information on what is needed in the trades.

Recommendations for curriculum content are presented by NACOME on pages 138-139. The tenor and flavor of these recommendations were well received by the MCTM Sub-Committee. There was enthusiasm especially for the first two recommendations:

> That logical structure be maintained as a framework for the study of mathematics.
>
> That concrete experience be an integral part of the acquisition of abstract ideas. (page 138)

We would stress that concrete materials are especially important when introducing new concepts. Even with concrete materials, principles that are important for the long-term development of key mathematical ideas need to be stressed so that a logical structure emerges for the learner.

Calculators

Recommendation e) on the same page which states that calculators should be allowed in all mathematics classes after grade 8 did create much discussion. While the MCTM Group agrees with the overall flavor of the report dealing with calculators, there are paper and pencil computational objectives for students in secondary school. For such objectives, calculators would not be appropriate. The MCTM Sub-Committee agrees that recommendation e) should be modified as follows:

> Recommendation: There are times that the goals of a teacher and/or students are not consistent with the use of calculators. At such times, students should not have calculators.
>
> MCTM should exert a continuing effort to identify times when calculators should and should not be used.

The Sub-Committee agreed also that teachers should not be afraid to incorporate calculators into classroom instruction in mathematics at all grade levels. Existing research indicates that calculators will not have an adverse effect on achievement. Ways may be found, in fact, to enhance achievement in mathematics, using calculators. Evidence is needed on the effect on achievement of long-term use of calculators.

The MCTM Sub-Committee agrees with the recommendation on page 145 that instructional materials at all levels be developed in the use of calculators. We wish to go further:

> Recommendation: Calculators have implications for standard courses such as algebra and trigonometry. These implications need to be identified in explicit ways and made available to curriculum leaders and textbook authors.
>
> Recommendation: A course emphasizing applications, consumer affairs, and practical mathematics should be developed for the secondary school with the calculator built in as an integral part of the course.
>
> Recommendation: The mathematical topics that are better taught using a calculator should be identified in specific terms and the results made available to curriculum leaders and to textbook authors.

Geometry

The MCTM Group agrees with the NACOME assessment of page 146, item g), that geometry in the school curriculum is not satisfactory. There is a need to reexamine the major goals of geometry and to see how geometry relates to other mathematics subjects.

Recommendation: The Michigan Council of Teachers of Mathematics should appoint a Commission consisting of interested and qualified personnel to study the goals of geometry, to make recommendations on the curriculum for grades K-12, and subsequently to develop one or more monographs illustrating the geometry content and approaches to the content at various grade levels. Special attention should be given to "hands-on" geometry at the elementary school and junior high school levels.

## Congressional and Legislative Relations

The NACOME Report points to the declining Federal support for curriculum work. Subsequent to the Report, even more drastic cuts were made. The reductions are traceable, in part, to Congressional Action. It is the view of this Sub-Committee that the mathematics education community was not represented adequately in the Congressional hearings. As a result, the following recommendations are made:

Recommendation: The National Council of Teachers of Mathematics should appoint immediately at least one person who will act as a liaison with Congress. The major responsibility would be to keep Congress informed about the needs for curriculum development in mathematics and needs in teacher education both at the pre-service and in-service levels. A further responsibility would be to keep the mathematics and mathematics education community informed about Congressional action.

Recommendation: The Michigan Council of Teachers of Mathematics should appoint immediately at least one person who will

act as a liaison with the Michigan Legislature. The responsibilities would be similar to those in the preceding recommendation.

The MCTM Group expressed concern that major decisions are being made at local school levels without adequate consultation with mathematics education specialists in the school system. Too often school decisions are made by those not knowledgeable either about curriculum or about course needs of students. Consequently, the following recommendation is made:

> Recommendation: Specialists in mathematics education should be consulted by superintendents, directors of instruction, School Boards, principals and legal authorities, including judges, involved in school decisions, on all matters affecting mathematics curriculum, learning, or instruction.

## Needed Repository for Curriculum Materials

The NACOME Report did not address itself to needs that teachers have for current curriculum materials. The MCTM Group expressed a strong interest in current materials and recognized that a central repository is not available to teachers of Michigan.

> Recommendation: A central repository of curriculum materials should be established in Michigan, as a part of an Intermediate School District or in the city of Detroit. There should be established an Operating Committee to screen all materials to be placed in the Center and to make recommendations on the operation of the Center.

Several such centers exist in the country, for example in St. Louis and in Kansas City. These centers should be visited before a Michigan Center is established.

## II. BASIC SKILLS

The NACOME Report states "that every child is entitled to the mathematical competencies necessary for daily living in today's civilization, but the concept of 'basic skills' essential to the consumer and the citizen (must) be defined to include more than computational skill - also abilities to deal intelligently with statistical information, to reason logically, and to think critically." (page 137 #2a) This MCTM Committee agrees that "basic skills" must be more than computational skills. We would broaden the definition of basic skills even further than NACOME.

Recommendation: Basic skills should be defined as follows:

1. Appropriate computational skills. Children should be able to compute with whole numbers, decimals, and percents. They need to understand the concept of fraction, equality of fractions, and simple ratios and proportions. With the introduction of metrication and calculators, operation with common fractions are less essential.
2. Problem solving. Applications of mathematics should not be limited to "word problems", students should be presented with problems in a physical setting as well. They should have an opportunity to learn a multitude of strategies for solving them - such as posing questions, simplifying a problem using diagrams and graphs, and trial and error.
3. Applying mathematics to everyday situations. Students should be able to take everyday situations, translate them into mathematical expression, solve

the mathematics and interpret the results in terms of the initial situation.

4. Estimation and approximation. Students should be able to carry out rapid approximate calculations. Oral work and mental estimation should be emphasized. They should acquire some simple techniques for estimating quantity, length, weight, etc.
5. Constructing, reading, interpreting tables, charts and graphs as well as descriptive statistics.
6. Measurement. Students should be able to measure distance, weight, time, capacity, temperature, angles and calculate simple areas and volumes. Emphasis should be placed on active learning and evaluation.
7. Using Mathematics to Predict. Students should have experiences with elementary notions of probability and statistics as they relate to everyday events - consumer product surveys, TV ratings, elections, weather forcasting, etc.
8. Dealing with the 3-dimensional world. (geometry) Recognition of shapes, their similarities, differences, and relationships is a necessary entry level skill for the job market.
9. Computer and calculator literacy. Knowledge of the uses, capabilities, and limitations of computers and calculators, pervasive in our society, is essential for all citizens.

The description of basic skills is an adaption of a list prepared by the National Council of Supervisors of Mathematics in April, 1976. The order of topics in the list of basic skills does not imply priority and it does not imply a sequence for teaching. The MCTM Sub-Committee emphasizes that all areas

listed have implications both in elementary and secondary curricula, although a few (#7, and the computer part of #9) may be more heavily oriented toward secondary levels.

The Minimal Performance Objectives for Mathematics in Michigan does not cover all these "basic skills". Minimal level objectives need to be developed to match those areas that are overlooked. Attention should also be given to sequencing those objectives. Further, we agree with another NACOME recommendation "that minimums cannot be allowed to become ceilings for student performance." (p. 137, #2b) Minimum objectives ten to limit not only what is taught, but also, teacher expectations for students. Program quality and student achievement should not be measured solely by performance on minimal skills tests. Other evaluative tools need to be developed. Finally, objectives beyond the minimal level need to be defined in all "basic skill" areas.

For teachers already faced with the multitude of tasks associated with teaching, we are sensitive to the "curriculum crunch", i.e., the suggestions that an ever-growing mathematics curriculum be increased once more. In regard to this, we make the following observations:

1. Computational skills are not a prerequisite for most topics listed on pages 8-9. A great deal of geometry, measurement, use of graphs, problem solving, as examples, can be taught and learned independent from many computational topics.
2. Most topics listed on pages 8-9 are not in sequence with one another. Concepts in problem solving, measurement, graphing, for example, can be introduced at any level and at any time of year. Just because a publisher places these topics at the end of a text should not mean their relegation to low priority on the curriculum agenda, much less their omission.
3. An appropriate style of instruction can incorporate many objectives into a single lesson. Estimation, for example, can be a part of all lessons. (Note: estimation

can serve as a motivational device, too. Once students have announced "guesses", they have a vested interest in finding exact results.) Problem solving and applications, similarly, overlap most other content areas. Monographs would be useful elaborating specific strategies to integrate problem solving or estimation into other curriculum topics.

## III. CURRICULA FOR ALL STUDENTS

In the NACOME Report it is asserted, "Those who are concerned about the education of young people must reaffirm their commitment to full comprehensive mathematics education for all..." (page 137). The MCTM Sub-Committee chose to follow up this suggestion by giving added discussion and recommendations on three special needs in curriculum.

### Mathematics for Remedial Instruction

We agree with the NACOME recommendations that minimal skills cannot be allowed to become ceilings of performance for any youngster (p. 137) and that effective materials and techniques for remedial instruction need to be developed (p. 146).

The curriculum for remedial instruction should include more than computational skills. Basic skills and computation skills are not synonyms. (See Sec. II) Additional research is needed to identify appropriate strategies for "reteaching" topics and techniques for diagnosing errors in thinking by students experiencing difficulty with mathematics. The most effective strategy for initially teaching a topic may not be the most effective one for reteaching it. For remediation to be effective, the teacher needs techniques to identify errors in thinking that need correcting.

Regardless of materials or techniques, we are concerned about social and academic consequences of the indiscriminant use of "labels" for studens below average in mathematical background. Most labels tend to overshadow the fact that any

class is composed of individuals with distinct needs and hinder the search for reasons why the student has not learned much mathematics. Labels such as "slow learner", "non-college bound", and "underachiever" should not be allowed to determine ceilings of performance or limit a student's opportunity to develop a good self image.

Mathematics clinics staffed by trained personnel and tutoring by college or other volunteer students can be used as supplements to classroom instruction. The grouping of students significantly behind their classmates in the learning of mathematics into special classes can be beneficial if the criteria used for selection is primarily based on lack of achievement in mathematics; class sizes are small enough to encourage use of more individualized approaches of instruction; the basis for teacher assignment to these classes is more than lack of experience, seniority, or ability; and provision is made for vertical movement in the curriculum if a student makes significant improvement in achievement. The assignment of a student to a remedial class should not necessarily become a permanent assignment.

## Mathematics for the Gifted Student

Current trends cited by the NACOME Report (p.23) and the resulting emphasis on "basic skills" have overshadowed the needs of the gifted student at all levels of instruction.

A major issue with regard to programs for the gifted is that of "acceleration vs. enrichment". In general, we favor a program of enrichment, especially for pre-high school students, but realize that acceleration is appropriate for a very selective group of students. When students are placed into accelerated programs, the criteria used is crucial and should be basec on a variety of factors. Only the very able should be accelerated. If students meet the criteria for entry into an accelerated program, students, in consultation with their parents, should have the option to select either an enriched or accelerated course of study in mathematics.

To maximize effectiveness, the goal of enrichment should be more productivity and depth of study, not merely "more of the same". When possible, enrichment should be related to the regular instructional sequence. Activities which can be used to foster and support a program of enrichment include mathematics clubs, mathematics competitions, and mathematics fairs and projects. If staffed by competent personnel, a mathematics clinic could be used for providing both remedial instruction and enrichment. At all levels, (especially the elementary level) provisions for the gifted student should be more than self-paced work with the student working at his or her own pace.

The needs of the gifted student need to be addressed. The MCTM should consider sponsoring a special conference or monograph on meeting the needs of the gifted student.

Broader Selection of Course Offerings

Since their selection of courses is usually more limited, this section will focus on the needs of the "average" student at the high school level.

We agree with the NACOME recommendations on the need for a statistics course with no algebra prerequisite (p.148) and computer science courses for all students (p. 139).

> Recommendation: The statistics course for secondary school should be designed to allow students from any grade level, 9-12, to enroll in the course.
>
> Recommendation: New course offerings for the average student should be developed to include possibilities such as: a) a non-proof geometry course focusing on geometric content; b) a practical or applied trigonometry course; and c) a consumer or applied course that is calculator-based (See Recommendation, page 5)

The content of these courses should be consistent with the NACOME recommendations (p. 138) that logical structure be the framework for the study of mathematics and that concrete experiences be an integral part of the acquisition of abstract ideas. Applications should be important, but not the main organizing, element of these courses. They should not be merely "watered-down" versions of college preparatory courses but should be courses designed especially for the needs of the average student. One implication is that the widespread practice of offering Algebra I as a two-year course should be scrutinized carefully. Some of the "new" courses recommended earlier could be offered as semester or half-semester courses, allowing a student more course options.

## IV. METRIC EDUCATION

Since the metric bill passed by Congress became law in December, 1975 after being signed by President Ford, agencies and organizations in every state have been preparing for metric implementation. The MCTM Sub-Committee supports the implementation efforts and the NACOME recommendation that the measurement strand and the fraction/decimal sequence be studied carefully for revision in relation to the metric changeover. (See pages 43-44 and 139 of NACOME)

Activities in Michigan. The MCTM has published two monographs and another is in press. Two of them contain specific activities for presenting the metric system to children. Inservice has been promoted through the use of "metric trunks". The Michigan Mathematics Objectives (MPOMEM) have had the measurement strand revised so that metric measurement is the only system used.

The State Department of Education of Michigan has a grant from USOE to implement a metric inservice project. It involves: (1) State regional media centers which will maintain metric trunks and (2) use of over 40 people to train teachers on the use of the metric system. Each school district in the state will receive inservice education.

Nationally, the National Council of Teachers of Mathematics has several publications available for teacher and inservice leader use.

Recommendations. The MCTM subgroup advances several recommendations for mathematics educators in Michigan.

1. Metric education development and implementation should be carried out with careful thought and planning.

   Particular attention needs to be given to:
   a) measurement as a "whole" and the way in which metric fits into measurement,
   b) the way metric fits into the overall curriculum; e.g., implication for fractions and decimals, for other school subjects.
2. A Commission should be established by MCTM to:
   a) carefully study the fraction and decimal sequence as it relates to or is affected by the metric system,
   b) develop a teaching sequence for fractions and decimals, e.g., fractions will remain, early use of decimals for tenths,
   c) develop a teaching sequence for metric as a whole.
3. MCTM should develop curriculum units for the teaching of metric making use of the Commission findings (above).
4. Specific attention should be given to:
   a) teaching metric at the middle school/junior high level (or where no previous metric experience has been offered yet some knowledge of measurement exists),
   b) high school students who either are not enrolled in a mathematics class or who are in classes not readily adaptable to teaching metric.

      Mathematics teachers have an obligation to provide experiences so non-mathematics students become knowledgeable in the metric system.
   c) Inservice of non-mathematics teachers such as home economics, vocational education, etc.

There is a need for mathematics teachers to help other teachers learn about good metric practice. It is also important for mathematics teachers to be informed by other teachers as to their needs and ways mathematics teachers can be of help. A two-way street exists.

d) Community education--including persons other than parents. It is the role of the school and mathematics teachers in particular to educate the community about metric, e.g., parent nights, community newsletters, the news media, adult education courses, neighborhood programs, etc, The NCTM is collecting reports and information about numerous programs of metric education which were held during the May 1976 National Metric Week.

MCTM/NACOME SUB-COMMITTEE ON INSTRUCTIONAL ISSUES

Patterns of Instruction

We believe that diversity in patterns of instruction in mathematics is desirable. We agree, in general, with the NACOME analysis that teachers need knowledge about and experience with a wide variety of approaches and teaching strategies in order to make rational decisions concerning their own classroom activities. At the same time it is clear that no one pattern, approach, or strategy is a panacea. We endorse the statement in the summary of Chapter 3 in the NACOME Report that teachers should be "eclectic pragmatists selecting those methods and materials, which seem to work best for a particular student or group of students working with a particular concept". However, we would include content along with methods and materials.

Alternatives in Classroom Instruction

The NACOME analysis describes three alternatives to traditional instructional patterns: (a) individualized instruction programs; (b) laboratory and materials-oriented programs; and (c) problem-centered interdisciplinary programs. We support the point of view expressed by the NACOME Report on alternatives b, and c, but we raise serious questions concerning individualized instruction programs.

We agree with NACOME that most individualized programs claim to provide learning experiences designed specifically for each student, i.e., matching the content, presentation mode, and pace of teaching to the unique capabilities of each student. We support the NACOME criticisms that few such programs really accomplish this matching, and that most of the individualization has to do with pace. Other disadvantages cited by NACOME are that individualized programs place excessive emphasis on isolated, low level computational skills; there is too little interaction among students and teachers; the children develop a tendency for learning primarily to pass tests; and the

teachers face a tremendous increase in record keeping. Of all these disadvantages, we believe the most significant one is the lack of interaction among students and teachers. We support the concept of individualization, but doubt the effectiveness of highly structured individualized programs. There is a large body of literature which suggest that the way these programs are used is important. We suggest that teachers read, for example, the analysis by Joseph I. Lipson, "IPI Math - An Example of What's Right and Wrong with Individualized Modular Programs", Learning, March 1974; the article by Phares G. O'Daffer "Individualized Instruction - A Search for a Humanized Approach", Arithmetic Teacher January, 1976; and the report by Stanley H. Erlwanger, "Benny's Conception of Rules and Answers in IPI Mathematics", Journal of Children's Mathematical Behavior, Autumn, 1973.

In laboratory oriented programs such as the Madison Project and the Nuffield Project, the emphasis is on discovery learning. Some of the advantages of the activity programs pointed out by NACOME are the concept of active learning, children doing mathematics, seeing mathematical implications in everyday situations, and conducting mathematical investigations using everyday materials and ideas. We agree that laboratory oriented programs have the potentials cited, but suggest that the effectivenss depends mainly on the teacher. Some criticisms reported by NACOME are that the outcomes are not always clear and may be "fragmented, uneven, difficult to assess or even based only on faith." Despite the difficulty of expressing goals of these programs in behavioral terms, we believe that the motivation and high interest associated with laboratory oriented programs tend to promote learning. The need is evident for more evaluation research data similar to that from the Specialized Teacher Project in California reported by NACOME.

Potential Misuse of Minimal Objectives

There was much discussion on the recent shift from general objectives which teachers have always considered, to specific

behavioral objectives. In Michigan, the development and subsequent revision of the Minimal Performance Objectives for Mathematical Education in Michigan has been a cooperative effort of the Michigan Council of Teachers of Mathematics (MCTM) and the Michigan Department of Education (MDE). Cooperative conferences have been held to provide teacher reactions to both the objectives tested and the assessment instruments used to measure student achievement of those objectives. The MDE has partially funded these conferences and the MCTM has conducted each of them. Some teachers seem able to incorporate these objectives into their total mathematics program without allowing the statement of objectives to dominate classroom procedures. For these teachers, the objectives can have a positive influence on instruction. However, we suggest that relatively few teachers are able to do this. There are many teachers who do not make use of the State objectives even though minimal performance objectives for mathematics are available. Other teachers who know the objectives are available, often decide to skip enabling objectives and go directly to terminating objectives.

We believe that a mathematics program based on objectives may have a negative effect if the main emphasis is on the selected objectives that are to be assessed at the end of the year. Teachers may very quickly become involved in narrowing the curriculum by teaching just the test items and not presenting a full math curriculum. The emphasis on testing causes teachers to overlook the development and understanding of mathematics. Furthermore, classroom methods, strategies, and activities ten to beome very binding. We would rather see teachers free to use any method, strategy, or instructional pattern necessary to present a complete curriculum for the student. It seems evident that information about such materials, activities, and instructional patterns must be made available to teachers.

Inservice Education Needs

Creativity within an objective curriculum is possible by implementing a sound and selective approach to inservice. NACOME

calls attention to the need for teachers to participate in the design of inservice education. A 1974 NCTM survey of inservice reports that "88% felt a need for inservice work, but 61% felt inservice education has not fit classroom needs and 37% reported the inservice work they had had to have been a waste of time and energy". We strongly support the view that mathematics educators and administrators communicate with teachers in making any inservice plans. Opportunity should be provided for teachers to observe alternate methods for teaching certain objectives and different patterns of instruction, as well as to keep abreast of current needs and materials. According to the 1974 survey, most of the respondents had never seen any one else teach. Our group also places importance on helping teachers develop appropriate instructional patterns. We believe that more effective inservice programs are needed. We believe also that the leadership potential exists in Michigan to accomplish this important and difficult task.

> Recommendation: We recommend that an inservice program responsive to these needs be planned and implemented for teachers in Michigan. The Michigan Council of Teachers of Mathematics, in cooperation with the State Department of Education, could accomplish this task.

Teachers' Centers

NACOME recognizes the teachers' center as the teaching profession's own attempt to update and maintain its preparation. Our study group endorses a teachers' center format that allows teachers to assess needs. But the development of a teachers' center must use more than a survey of teachers' inservice needs. Centers should design and modify inservice programs in cooperation with local school administrators, local mathematics educators, and professional mathematics organizations. A teacher

center might be funded cooperatively by teachers through participation, membership cards, or by school districts matching funds with local corporations and foundations. The notion of a teachers' center as exemplified in England and many places in the United States appears to have great possibilities for continuing development of teachers. In particular the Detroit Center for Professional Growth and Development may be a good model for other areas in Michigan.

Needed Research

The NACOME Report recognized that there is very little factual information about what is really going on in mathematics classrooms throughout the country. So little was known that NACOME undertook a small survey (1200 responses) to get some additional data. We believe that it is essential to gather information about existing patterns of instruction in Michigan.

> Recommendation: We recommend that a study of instructional patterns in Michigan be made. This study might be similar to the exploratory NCTM survey reported by NACOME, but classroom visitations should be included. The State Department of Education, in cooperation with the Michigan Council of Teachers of Mathematics, is suggested as the agency to carry out this study.

## MCTM/NACOME SUB-COMMITTEE ON TEACHER EDUCATION

### Preservice Education

Feedback from teachers now in the field gives strong evidence of a need for much more thorough and better coordinated preservice preparation in the teaching of mathematics at all levels.

Specifically, there are the following difficulties in implementing the many recommendations for preservice education improvement made over the past fifteen years:

a.) Colleges of education and mathematics departments have often only been able to negotiate 3-5 semester hours of mathematics and mathematics education credits for elementary teachers - if that - when 12 were recommended by CUPM. In addition, numerous mathematics courses are taught to preservice teachers by mathematics teachers who are not interested in or are unaware of the "needs" of those being trained. b.) Professional mathematics education organizations have served many good purposes but perhaps in the future it would be wise for organizations such as NCTM and MCTM to take a stand on such controversial movements as Competency-Based Teacher Education and Performance-Based Teacher Education. (MCTM reacted quickly in producing Minimal Performance Objectives in response to steps in that direction taken by the Michigan Department of Education.) c.) The whole mathematics education community including professional organizations really need to feel responsible for maintaining a sound college curriculum due to the following situations: (1) Traditionally in Michigan the colleges have determined the standards for teacher certification and, (2) accrediting agencies such as NCATE do not usually speak to the concerns of mathematics teaching. d.) There is almost a complete lack of emperical data on which to formulate a basis for "good teaching."

Good preservice education is needed by all teachers of mathematics whether they will instruct at the elementary or secondary level. For improving preservice teacher education, in the light of the NACOME Report, we make the following recom-

mendations for preparing teachers to teach mathematics:

Recommendation 1: MCTM, the Michigan Department of Education and each mathematics department in a college or university responsible for training mathematics teachers for grades 6 through 12 should begin active advertising and recruiting for the top high school senior and college freshmen mathematics students to consider mathematics teaching as their profession.

Recommendation 2: Create a committee on teacher education in the faculty senate of each teacher-education institution. This committee consisting of representatives of each academic department as well as the college of education, should be charged to review and recommend teacher training policy, coordinate planning, and in particular, to examine, establish and administer the requirements necessary for a student to enter and stay in the professional teacher-education sequence at that particular school. Faculty instructing in the colleges of education must have 3-5 years of actual teaching experience in the grade levels for which they are preparing teaching candidates. Such actual classroom experience should be renewed every five years by exchange faculty assignments.

Recommendation 3: Screen carefully the student candidates desiring admission to the mathematics teacher education sequence of each Michigan college or university. In particular, the committee on teacher education should establish a grade point entry requirement substantially above average. To maintain candidacy, the teacher candidate must maintain the entry grade point average. Before admitance to mathematics methods courses, elementary school teacher candidates should score 80% or better on a standardized middle school mathematics test.

Recommendation 4: Each Michigan teacher-education institution must explore every method to establish early college student exposure to classroom experience and contact

with the teaching situation. Long before admission to candidacy and formal student teaching, the student should have operated in the following situations: 1-1 tutoring, small group work and full class situations.

Recommendation 5: Create yearly MCTM sponsored conferences on the campuses of teacher-education institutions. These to be especially designed to have prospective teachers meet and talk with recent graduates having, at least, two years experience and MCTM personnel. Careful monitoring of such conference interaction could prove invaluable in planning future teacher training. These MCTM Conferences should be designed especially to help and to learn from the second year mathematics teacher. MCTM, the office of the State Supervisor, and teacher educators should collaborate on designing the program, collecting data from the participants and using that data to plan research, modify present programs, and so on.

Recommendation 6: Yearly MCTM mailings must be made to each Michigan institution preparing teachers. This would include copies of M.I.M. student enrollment forms for MCTM and a brief overview of MCTM activities and goals.

Recommendation 7: Each continuing certificate issued to a teacher of secondary mathematics should be accompanied by a questionnaire to obtain feedback information on that teacher's experience so as to improve future teacher education programs.

Recommendation 8: MCTM officers and others concerned with preparation of teachers should submit articles outlining MCTM positions, concerns, needs for support, etc. to the Michigan journals of principals, school boards, and other academic disciplines so that efforts and concerns are better understood, more widely distributed and available for others with like problems or strangths to interact with us.

Recommendation 9: An entire issue of Mathematics in Michigan (M.I.M.) should be devoted to teacher training questions and designed as a questionnaire to get feedback from the membership.

Recommendation 10: Each MCTM member desiring to speak to the issue of teacher preparation should submit specific recommendations to MCTM.

MCTM/NACOME SUB-COMMITTEE ON TEACHER EDUCATION

Inservice Education

"He who dares to teach must never cease to learn." This maxim underlies the recommendations made in this position paper.

The need for in-service education ceases during a teacher's career. New demands arise continually because of the constant change in sociological patterns that result from our highly mobile population, technological advances such as the calculator and computer that impinge upon education, advances in the theories of learning and cognition, and the continuous outpouring of physical materials designed for helping children and youth learn mathematics.

Furthermore, the escalation of thinking and cognitive skills required for intelligent citizenship in our democratic society and the changing expectations for entry skills of those entering the world of work or for matriculation in college programs leading to the professions demand continuous review of the curriculum content as well as methods of instruction.

Teachers want help. In 1974 the Commission on the Education of Teachers of the National Council of Teachers of Mathematics conducted a survey of a random sample of its members who were junior and senior high school mathematics teachers. Of the 266 respondents 88% felt a need for in-service work but 61% felt that prior in-service had not met their classroom needs. Seventy-five percent thought that teachers should be released from classroom responsibilities for in-service education and 90% felt that school districts should make it available. The recommendations contained in this paper reflect the expressed feelings of the teachers in the survey.

Considering the needs of Michigan teachers for in-service education, the available programs would seem to be haphazard, non-programmatic and probably suffer from a lack of comprehensive, long-range planning.

If Michigan educators in general and teachers and teacher educators in particular are to provide Michigan school learners optimal instructional opportunity for educational growth, then,

ethically speaking each individual teacher and teacher educator must engage in continuous professional development. Many teachers accept responsibility for their own professional development,but there are others who do not. We are speaking to both groups of teachers. All should have opportunity for programmatic inservice. Further, the teachers in the latter group cannot be defended in today's rapidly changing world.

In order to improve the inservice education in mathematics and to ultimately improve the mathematics programs offered to Michigan pupils, there are two basic requirements. First, we need to have a comprehensive and accurate description of the instructional practices and materials used to teach mathematics. Secondly, we also need a practical means of collecting and sharing information describing research studies of innovative programs or projects.

Believing in these two requirements for improving mathematics instruction, we make the following recommendations.

> Recommendation 1: The Michigan Department of Education should collect data from teachers in the State of Michigan on classroom practices, teacher education programs in the state, materials being used and innovative curricula.

To implement this recommendation we suggest:

That information could be collected using representative sampling procedures with well-structured questionnaires so that accurate information can be collected in an economically feasible manner. As NACOME points out, very little is known about the practices actually used by classroom teachers. Such data is needed for intelligent planning of inservice education.

> Recommendation 2: A clearinghouse should be established for collecting and disseminating information on research activities in the teaching of

mathematics in Michigan schools, intermediate school districts, the Michigan Department of Education (MDE) and Michigan colleges and universities with teacher education programs.

To implement this recommendation we suggest:

1. That the MDE
   - 1.1 Stimulate research in mathematics education by working with the State Legislature and the Governor to secure funds for research.
   - 1.2 Expend research funds principally on longitudinal studies of children in classroom stiuations to determine those teaching practices that make a lasting difference. To encourage the best use of such monies, the MCTM should seek to reactivate its resolution to the 1974 NCTM Delegate Assembly regarding the creating of a Center for Longitudinal Research in Mathematics Education. Specifically, the professional organizations should formulate and make available to interested agencies priority lists of research needs, goals and plans.
   - 1.3 Collect information continually on research being undertaken and that which has been completed. It is expected that the person doing the research will submit a statement of the problem and a brief summary of the proposed study. At the end of the study the researcher would be expected to submit a succinct summary of his conclusions along with their implications for the classroom teacher.
   - 1.4 Maintain a data bank of research activities and results in the State of Michigan.
   - 1.5 Publish a newsletter with pertinent information going into the data bank that has implications for affecting classroom practice.

2. Establish a procedure to encourage and facilitate the cooperation of superintendents and other administrative personnel, advisors of doctoral students, and the researchers who would be contributing to the data bank.

> Recommendation 3: Inservice programs should be based on current assessments of needs gathered from teachers, supervisors, administrators, teacher educators, school board members, parents, citizens and students.

To implement this recommendation we suggest:

1. Collecting the data
   - 1.1 Questionnaires that are precise, easy to complete and that retain the respondent's anonymity should be used to collect the bulk of the data from a representative sample that is relatively proportional to the eight populations named in the recommendation.
   - 1.2 The State Department of Education and MCTM should hold a series of open meetings at centrally located parts of the state for the purpose of discussing inservice needs. Such meetings should be taped to allow for later analyses.
   - 1.3 Face to face interviews with a small randomly selected segment of each of the eight groups should be conducted in conjunction with the meetings in 1.2 above.
   - 1.4 So that adequate teacher response is assured, specific meetings should be held in individual schools and school systems. MCTM and the State Department should spearhead these meetings, as well.

While the mails and the questionnaire offer the best access to an unbiased study of inservice needs, the local professional mathematics meetings present a constant source of subjects for data gathering. In the beginning, MCTM, the State Department and the teacher education institutions could perform the data

gathering and compiling, as often as feasible, perhaps every three years. The same information from the professional meetings should be compared to the all state results. The comparisons could indicate whether the data from the professional meetings are valid reflectors of the state inservice needs, although a rather selected group of teachers attend such functions.

2. While the State Department of Education and the colleges and universities should collaborate in collecting and organizing the data obtained, MCTM should use the Teacher Education Committee to interpret the findings and issue printed recommendations.

Recommendations for inservice education should reflect considerations for the requirements of the ultimate consumer, the K-12 learners. While both the classroom practices survey and the results from the state assessment could be used to assure that Michigan students' needs are a viable part of inservice projections, the best fit of teacher training to classroom needs will come only when sufficient longitudinal classroom data is available.

3. Based on the MCTM recommendations for inservice, the State Department and MCTM should develop representative workshop schedules and plans that would be available to interested schools, school districts and teacher centers. These workshop guides could be issued as MCTM monographs. Assuming the broad base of the needs assessment, these plans would encompass mathematical content, learning theory, instructional modes, instructional aids, developmental sequencing and evaluation.
4. With NCTM, MAA, CUPM, NSF and NIE, all interested in inservice education, MCTM should propose to any or all of these agencies that Michigan be a pilot for gathering adequate data for judging components of an effective inservice program. Such data as suggested in Recommendation 3

seems to be totally lacking, at present. The success of the inservice alternatives developed by any of the mentioned organizations will be related directly to the data on which the programs are based.

> Recommendation 4: School systems and individual schools should develop long range plans for inservice activities, aided by the monographs from Recommendation 3.

To implement this recommendation we suggest:

Since funds for training have a way of appearing out of the blue, only a master plan offers an efficient use of time and money. The next phase is always available whenever the opportunity arises for additional sessions.

1. The following items should be included in any master plan:
   - 1.1 A list of accessible, comfortable sites for various kinds of inservice activities should be maintained as part of the plan. The work and storage space in each should be known as well as the feasibility for serving light refreshments.
   - 1.2 Lists of knowledgeable consultants should include their educational and experiential backgrounds, areas of expertise and times of availability. Above all these, consultants should have had several years of actual elementary and/or secondary teaching experience as well as continued interaction with the present classroom scene.
   - 1.3 Compile a source index for a wide variety of materials such as minipulative aids, art supplies, resource books, shop materials, texts and basic building tools.
2. Develop several overlapping modes for informing educators about the workshop sessions. Newspapers, U. S. mail service, faculty meetings might all be used.

3. Each session, as well as the final one of a series, should have provision for a direct, anonymous, written evaluation by all in attendance. On a more random basis, long term reactions to the inservice should be recorded. A second questionnaire could be sent to a limited population. This could seek the teaching changes, improvements and difficulties that these teachers or other educators have been aware of using that might be traced to the effect of the additional training. While pupil achievement is a difficult factor to relate to inservice, certain agencies are demanding this as part of the evaluation, so the same comparisons should be included as part of all workshops.
4. The evaluations should be interpreted by a workshop committee and/or the staff as a whole. Did the session(s) complete a phase of the master plan? Is more needed? Does pupil achievement reflect improvement? Can the workshop activities help account for this improvement?
5. Using the evaluations and the interpretations, the master plan should be adjusted so that future activities will respond to current needs, maintain continuity and continue to elicit staff participation.
6. Unless NCTM, MCTM and the State Department of Education offer direct assistance to Michigan schools in carrying out 1 and 5, these will be just so many meaningless phrases. The development of a trouble-shooting staff of consultants by the suggested agencies is a must, if inservice is not to remain the deadly ineffectual operation it often is now.

> Recommendation 5: School boards should provide released time for teachers so that they may take advantage of in-service education opportunities.

To implement this recommendation we suggest:

1. School systems develop planned programs for inservice education of their teachers.

2. Teachers should be encouraged to attend and participate in professional meetings such as those of the NCTM, MCTM and local organizations of mathematics teachers. Where possible at least part of the expenses for such professional activities should be paid by the school system. As a minimum, a substitute for the teacher should be provided without expense to the teacher.
3. Teachers should be stimulated to take graduate work related to their responsibilities in the school.
4. The MCTM should cooperate with the Michigan School Board Association, the AFT and the MEA to make this recommendation a reality.

> Recommendation 6: There is need for a united front in education to provide the profession and the public with information on the goals, accomplishments and the needs of education.

At present, the news media decides what and how educational news is disseminated. For example, metric education will affect most subject matter areas, but, at present, science and mathematics teachers are concerned. Little in the popular press would lead other disciplines to see they need preparation and plans, as well.

To implement this recommendation we suggest:

1. MCTM should elicit the aid of the executive boards of other state professional, educational organizations and the lobbyists for the teacher unions, associations and school districts in formulating a monthly (weekly?) magazine on teaching in Michigan. This publication could be included in the Sunday editions of major newspapers. Such an organ would greatly facilitate the dissemination and diffusion of information to educational practitioners and the general public. Being produced by Michigan educators for Michigan

educators, the publication would reflect the views and concerns of Michigan teachers.

MCTM's Executive Board should authorize the Teacher Education standing committee to conduct a desirability study of this endeavor with counterparts in other professional organizations. Assuming positive results, a feasibility study should be carried out prior to implementation of the magazine. The professional groups should extend the effect of the publication with weekly or bimonthly TV news spots aimed at the non-newspaper reading public.

2. Communications concerning mathematics programs, the needs and successes, must flow from the mathematics and mathematics education departments in the universities and the professional organizations involved with mathematics to school administrators.
3. MCTM should arrange for the printing of articles on methodology, new programs, new topics such as metrication and the calculator in the journals of the various organizations for administrators, such as The National Association of Elementary Principals and The National Association of Secondary Principals. These writings could be reprints from the various mathematics education journals or Mathematics In Michigan. Seldom do items on mathematics teaching appear in administrative bulletins.
4. MCTM should appoint a public relations officer and/or committee to scan current general publications, especially newspapers, news magazines and commercially printed educational newsletters for erroneous or slanted news, such as quoting, as an authority, one high school principal about the "success of the 'new mathematics". These committees would contact the particular publication with a letter or article containing views more reflective of most mathematics educators.

Public relations is the name of the game today...far too long educators have operated on the assumption that "good will out". Especially in mathematics education, practitioners must aggressively inform or misinformation will continue to reign!

MCTM/NACOME SUB-COMMITTEE ON EVALUATION

A Proposal to the MCTM Board of Directors for the Support of Mathematics Evaluation Efforts in Michigan Schools

## INTRODUCTION

In discussing the status of evaluation in mathematics education, the NACOME Report states that more "critical attention needs to be given to this area" (page 142) due to its prominence and value in education today. It stresses the essential and useful nature of evaluation in instructional programs, but discusses the serious problems of crude and inappropriate instruments which fail to measure the specific objectives of mathematics programs.

In order to ensure quality education NACOME also attests to the necessity of providing continued support to mathematics teachers by qualified resource specialists in curriculum and instruction. This study group unequivocally supports these NACOME positions on evaluation and quality mathematics education; we feel that intensive efforts should be made by MCTM and specific universities to offer professional inservice help to local school districts and classroom teachers who need assistance in evaluating their mathematics programs and implementing appropriate changes for program improvement. Such assistance is especially needed in districts which have no consultative help available either locally or through intermediate district personnel.

In view of a number of controversies which have been related to educational accountability here in Michigan and elsewhere, the committee feels that MCTM could provide important constructive leadership by promoting programs which lead to effective evaluation programs in Michigan schools.

As a means of providing such support, the committee recommends a two-part effort.

1. The activation of a task force to prepare a description of the "basic" ingredients necessary for evaluating Mathematics programs.

2. The joint development with a Michigan teacher training university to assist schools in the development of mathematics evaluation programs.

## DISCUSSION

In arriving at those recommendations a number of points of view related to mathematics evaluation programs were agreed upon. Those points of view provide background for the recommendations, a basis for considering their approval and a framework for implementing each of the recommendations.

### Focus on Improving Instruction

We feel that the primary purpose of the evaluation should be the improvement of mathematics programs. While such a program would also provide a basis for responding to demands for accountability that function should be clearly secondary. While individual teachers are very likely to react constructively to information provided by an evaluation program which clearly focuses on improving instruction, one with a primary emphasis on accountability can represent threats which inhibit improvements. A well-designed program will make some provision for meeting both functions.

### Subjective Judgment Vs. "Hard" Data

A heavy reliance of subjective judgment has characterized many evaluative efforts in the past. While such judgments are needed when they are not backed up by more objective data many inaccuracies can result. Such misinterpretation of results seriously handicaps program improvement efforts and in many instances can be seriously detrimental to the learning of students. On the other hand, reliable information can vastly improve decisions concerning:

--which students to place in special classes
--how much class time to spend on specific objectives
--when new materials are needed and what special features they should have

--what topics should receive a high priority in the use of staff-study time and inservice monies
--which parts of the mathematics program are in most urgent need of study
--the balance between teacher spectations and reasonable quality in student performance
--etc.

School Systems Need Help in Developing Evaluation Programs

It is the feeling of the committee that many school systems do not use hard data to facilitate program improvement and/or evaluation. While that feeling was not in fact supported by a definitive study, the group is confident that the conjecture would be supported by such a study.

Description of a Basic Evaluation Program

The controversy which has surrounded the topics of evaluation and accountability has been such that schools or school systems which wish to initiate an effective evaluation program will find the literature very confusing. That being the case, the committee feels that it would be useful for the MCTM to make a clear, concise statement describing some basic characteristics of a minimal evaluation program in mathematics. Some of the issues which that statement might examine are:

--responsiveness to local needs
--the involvement of teachers in the planning and the design
--economy of time for teachers and students
--the need for simplicity and the pitfalls of using data which is not well understood
--the relationship of minimal basic programs to the characteristics necessary for programs of high quality
--sensitivity to needs of students and the characteristics of programs at the different school levels - lower elementary, upper elementary middle and high school

--systematic data gathering versus a crises orientation
--making a simple beginning and expanding as needs and staff sophistication require
--the variety of inputs written and non-written, cognitive and affective
--packaging data to encourage its constructive use

Workshop for Local Schools and/or School Systems

Even after the ingredients of an evaluation program are well-defined, many schools and/or school districts will find it difficult to make a beginning without outside assistance. The absence of available expertise, lack of perspective, vested interests, the absence of budgetary support and a number of other factors can make it very difficult to begin. We feel that the MCTM should actively support the initiation of functional evaluation programs by working with a teacher training institution to provide consultative help to specific school systems in developing such programs (as it has done in the case of metric education). If a workshop could be orgainzed in such a way that it can be taken to schools or school districts which request assistance. (Special MDE assistance in financing the venture would also provide added incentive to school systems to utilize this service.) The committee feels that a number of key factors should be considered in operating the workshop.

--the program must be meaningful and useful to classroom teachers - recognizing any limitations they have in the area of test and measurement.
--the program developed must be self-supporting at the local level. (i.e., it should continue after support is withdrawn)
--a major emphasis is placed on instructional improvement
--this task force approach can serve as a model which can be emulated by other teacher training institutions
--the activities are tailored to the needs of the educators involved

This assistance should include but not be limited to:

--clarifying concerns and problems
--identifying evaluative instruments which meet the goals of the program
--designing an evaluation program
--processing and interpreting data

While MCTM does not have the resources to assist each school system in the State of Michigan to develop an evaluation program, it is hoped that a model such as this would be transferable to other teacher training institutions and would, finally, influence the training of new teachers as well. In this way there is the hope that MCTM could, in fact, influence evaluation programs throughout the state.

School Systems Need Help

In view of past performance and the continued controversies related to evaluation, it must be concluded that without some form of special emphasis (such as those recommended here) many school systems in Michigan will not be able to develop the evaluation programs which would have much potential to support improvements in mathematics education.

MCTM/NACOME SUB-COMMITTEE ON EVALUATION

Position Statement on State Assessment in Mathematics

This Position Statement is in response to the evaluation section (pp. 103-134) of the Conference Board of the Mathematical Science National Advisory Committee on Mathematical Education's Overview and Analysis of School Mathematics Grades K-12 (referred to as the NACOME Report). The position statement was prepared at the Michigan Council of Teachers of Mathematics (MCTM) sponsored NACOME Conference of July, 1976.

The MCTM has cooperated with the Michigan Department of Education (MDE) in assessing the minimal mathematics competency of Michigan school children since the current criterion referenced tests were conceived in the early 1970s. MCTM has found the cooperation worthwhile and MDE responsive to suggestions. The Council hopes to continue cooperation with MDE in mathematics assessment.

Use of Assessment Results

MCTM sees value in the use of State assessment data for curriculum modification and program development. For example, State scores on test items covering decimal fractions have been helpful in calling attention to the need for increased instruction on this topic. This use of assessment data is, of course, limited to areas included in State testing.

MCTM believes that State test results should be used for diagnosing individual students needs only with great care. The State program was developed only for minimal objectives, and the limitation of testing to only a restricted set of this minimal set results in tests which offer only a very incomplete picture of a student's mathematical understanding. Competency on State-tested objectives should form only a small component of a school's goals in teaching mathematics.

Minimality

MCTM shares the concern expressed in the NACOME Report that a State program which tests only minimal objectives can have a detrimental effect by producing school mathematics programs primarily to meet the State minimal objectives and ignore the needs of the average and above average students who have already attained these objectives and need exposure to concepts above the minimal level. As stated by NACOME, "minimal skills cannot be allowed to become ceilings of performance". Concern has been expressed that a tendency in this direction exists in Michigan. MCTM believes that every effort should be made to maintain programs for the full range of students, that every student should be given the opportunity to full development of his/her potential.

Testing Time

Classroom time used for State testing is taken from time that would be otherwise used for instruction. Within the current limitations of minimality, test processing time, etc., the State program can accomplish only limited goals. Information required for State decision making the data that can reasonably expected to be useful for other purposes such as program development can be obtained with shorter tests. The MCTM recommends that shorter tests be devised and used.

Revision of State Objectives

MCTM supports the recent decision to revise the State Minimal Objectives for Mathematics Education. The Council is confident that the Capstone Objective format agreed upon will allow a more efficient assessment of minimal objectives, avoiding the over-testing of some objectives while others are by-passed which occurs in the current program.

MCTM/NACOME SUB-COMMITTEE ON EVALUATION

## The Place of Objective-Referenced and Norm-Referenced Testing in Evaluation

The NACOME Report recommends..."that an intensive effort be made to develop objective-directed tests to replace the standarized norm-referenced tests now commonly used for student and program evaluation". (page 142) This position has some merit to the extend that it is directed against abuses often seen in standardized testing.

The report is not against normative testing per se. NACOME objects to the practice of reporting test results by one or two standard scores each covering a range of content areas and cognitive levels.

The report implies that testing results should be reported as a vector of scores (short scales directed at specific objectives).

We do not feel that there is presently an adequate basis for supporting NACOME's recommendation. The literature is not clear as to the definition and purposes of objective-referenced tests. There are also many technical problems involving reliability and validity--including problems in obtaining national norms for objective-referenced tests.

An alternative point of view for the near future would suggest that both objective-referenced and norm-referenced test are needed. These two types of tests are concerned with different purposes. Their combined contributions give a more comprehensive as well as detailed means of evaluating instructional outcomes.

We fully support NACOME's recommendation to discontinue the use of grade equivalent scores.

Action We urge the MCTM to contact the Michigan Personnel and Guidance Association and the Michigan Educational Research Association to form a joint task force to study the uses of standardized tests in mathematics evaluation. The task force would spell out desirable practices and underscore abuses. The results of this study should be disseminated to the lay public and to various educational organizations including those representing school boards and school administrators.

## SUMMARY OF RECOMMENDATIONS

Each subcommittee developed specific recommendations. Most of these recommendations are directed to the Michigan Council of Teachers of Mathematics or the Michigan Department of Education for action. The MCTM/NACOME Study Group believes that the dissemination of these recommendations to appropriate agencies is a necessary first step in implementing selected ideas in the NACOME survey in Michigan. This summary does not attempt to establish priorities or to suggest a mechanism for review. The list of recommendations by the four subcommittees follows.

### A. CURRICULUM

1. The Michigan Council of Teachers of Mathematics should work in close cooperation with schools and with the State Department of Education in making suggestions for realistic expectations of students in the various school mathematics courses. Efforts should be made to give direction to content that can and should be deleted from the crowded curriculum.

2. There are times that the goals of a teacher and/or students are not consistent with the use of calculators. At such times, students should not have calculators.

MCTM should exert a continuing effort to identify times when calculators should and should not be used.

3. Calculators have implications for standard courses such as algebra and trigonometry. These implications need to be identified in explicit ways and made available to curriculum leaders and textbook authors.

4. A course emphasizing applications, consumer affairs, and practical mathematics should be developed for the secondary school with the calculator built in as an integral part of the course.

5. The mathematical topics that are better taught using a calculator should be identified in specific terms and the results

made available to curriculum leaders and to textbook authors.

6. The Michigan Council of Teachers of Mathematics should appoint a Commission consisting of interested and qualified personnel to study the goals of geometry, to make recommendations on the curriculum for grades K-12, and subsequently to develop one or more monographs illustrating the geometry content and approaches to the content at various grade levels. Special attention should be given to "hands-on" geometry at the elementary school and junior high school levels.

7. The National Council of Teachers of Mathematics should appoint immediately at least one person who will act as a liaison with Congress. The major responsibility would be to keep Congress informed about the needs for curriculum development in mathematics and needs in teacher education both at the pre-service and in-service levels. A further responsibility would be to keep the mathematics and mathematics education community informed about Congressional action.

8. The Michigan Council of Teachers of Mathematics should appoint immediately at least one person who will act as a liaison with the Michigan Legislature. The responsibilities would be similar to those in the recommendation above.

9. Specialists in mathematics education should be consulted by superintendends, directors of instruction, School Boards, principals and legal authorities, including judges, involved in school decisions, on all matters affecting mathematics curriculum, learning, or instruction.

10. A central repository of curriculum materials should be established in Michigan, as a part of an Intermediate School District or in the city of Detroit. There should be established an Operating Committee to screen all materials to be placed in the Center and to make recommendations on the operation of the Center.

11. The definition of basic skills should encompass more than that recommended by NACOME (See pages 8-11 of this report for details).

12. The statistics course for secondary school should be designed to allow students from any grade level, 9-12, to enroll in the course.

13. New course offerings for the average student should be developed to include possibilities such as: a) a non-proof geometry course focusing on geometric content; b) a practical or applied trigonometry course; and c) a consumer or applied course that is calculator-based (see Recommendation 4, page 43).

14. Metric education development and implementation should be carried out with careful thought and planning. A commission should be established by MCTM to study the fraction and decimal sequence as it relates to the metric system. (See pages 14-16 of this report for details.)

B. INSTRUCTION

1. An inservice program responsive to the needs of teachers be planned and implemented by the Michigan Council of Teachers of Mathematics in cooperation with the Michigan Department of Education.

2. The Michigan Department of Education should collect data on instructional patterns in mathematics classrooms. The study should include data on instructional materials as well as classroom practices.

C. TEACHER EDUCATION (IN-SERVICE)

1. The Michigan Department of Education should collect data from teachers in the State of Michigan on classroom practices, teacher education programs in the state, materials being used and innovative curricula.

2. A clearinghouse should be established for collecting and disseminating information on research activitie in the teaching of mathematics in Michigan schools, intermediate school districts, the Michigan Department of Education (MDE) and Michigan college and universities with teacher education programs.

3. In-service programs should be based on current assessments of needs gathered from teachers, supervisors, administrators, teacher educators, school board members, parents, citizens and students.

4. School systems and individual schools should develop long range plans for in-service activities, aided by the monographs from Recommendation 3, pages 29-31 of this report.

5. School boards should provide released time for teachers so that they may take advantage of in-service education opportunities.

6. There is need for a united front in education to provide the profession and the public with information on the goals, accomplishments and the needs of education.

(PRE-SERVICE)

1. MCTM, the Michigan Department of Education and each mathematics department in a college or university responsible for training mathematics teachers for grades 6 through 12 should begin active advertising and recruiting for the top high school senior and college freshman mathematics students to consider mathematics teaching as their profession.

2. Create a committee on teacher education in the faculty senate of each teacher-education institution.

3. Screen carefully the student candidates desiring admission to the mathematics teacher education sequence of each Michigan college or university.

4. Each Michigan teacher-education institution must explore every method to establish early college student exposure to classroom experience and contact with the teaching situation.

5. Create yearly MCTM sponsored conferences on the campuses of teacher-education institutions.

6. Yearly MCTM mailings must be made to each Michigan institution preparing teachers. This would include copies of M. I. M. student enrollment forms for MCTM and a brief overview of MCTM activities and goals.

7. Each continuing certificate issued to a teacher of secondary mathematics should be accompanied by a questinnaire to obtain feedback information on that teacher's experience so as to improve future teacher education programs.

8. MCTM officers and others concerned with preparation of teachers should submit articles outlining MCTM positions, concerns, needs for support, etc. to the Michigan journals of principals, school boards, and other academic disciplines so that efforts and concerns are better understood, more widely distributed and available for others with like problems or strengths to interact with us.

9. An entire issue of Mathematics in Michigan (M. I. M.) should be devoted to teacher training questions and designed as a questionnaire to get feed back from the membership.

10. Each MCTM member desiring to speak to the issue of teacher preparation should submit specific recommendations to MCTM.

D. EVALUATION

1. That the MCTM support mathematics evaluation efforts in Michigan schools by:

   a. The activation of a task force to prepare a description of the "basic" ingredients necessary for evaluating mathematics programs.

   b. The joint development with a Michigan teacher-training university to assist schools in the development of mathematics evaluation programs.

2. That MCTM continue cooperative efforts with the mathematics assessment and to urge the MDE to concerns regarding uses of assessment results, "minimality", amount of testing time, and the revision of statewide mathematics objectives.

3. We urge the MCTM to contact the Michigan Personnel and Guidance Association and the Michigan Educational Research Association to form a joint task force to study the uses of standardized tests in mathematics evaluation. The task force would spell out desirable practices and underscore abuses. The results of this study should be disseminated to the lay public and to various educational organizations including those representing school boards and school administrators.